

**Late Pliocene to Early Pleistocene donaciine fossils from the Uonuma
Formation in Higashikubiki hills, Niigata Prefecture, Japan,
with description of a new species
(Coleoptera: Chrysomelidae: Donaciinae)**

Masakazu HAYASHI*

新潟県中越地方，東頸城丘陵の魚沼層から産出した後期鮮新世—前期
更新世のネクイハムシ亜科の化石

林 成多*

抄録：新潟県刈羽郡小国町および高柳町の東頸城丘陵に分布する魚沼層から，多数のネクイハムシ亜科の化石が産出した。東頸城丘陵の魚沼層の時代は後期鮮新世から中期更新世初頭（約2.0-0.7Ma）にわたるが，ほとんどの化石の時代は前期更新世である。本地域の魚沼層から産出したネクイハムシ化石には9種が含まれ，少なくとも3種は日本からの絶滅種と考えられる。本論文では新種*Plateumaris virens* sp. nov. ウオヌマミズクサハムシを記載し，残る8種の化石の記載・検討を行い，魚沼層のネクイハムシ相の種構成や魚沼層から産出したオオミズクサハムシの進化的な意義について議論した。

Abstract: Abundant fossil donaciine beetles were obtained from the Uonuma Formation at Higashikubiki hills in Oguni and Takayanagi-machi, Kariwa-gun, Niigata Prefecture, central Japan. The age of this formation ranges from Late Pliocene to earliest Middle Pleistocene (ca. 2.0-0.7Ma), but ages of most donaciine fossils are Early Pleistocene. The donaciine fauna of the Uonuma Formation in the area includes nine species. Among them, three species are identified as the extinct species in Japan. In this paper, I describe a new species, *Plateumaris virens*, including descriptions of fossils of other species, and discuss the species composition of donaciine fauna and the evolutionary significance of fossil *Plateumaris constricticollis* of the Uonuma Formation.

Key words: Donaciinae; fossil; new species; *Plateumaris virens*; extinct species; Pliocene; Pleistocene; Uonuma Formation.

The donaciine beetles belong to the family Chrysomelidae and the modern donaciine fauna of Japan includes about 20 species. Several extinct species of this group are known from Pliocene to Pleistocene deposits (e. g. Kazusa Group in the Kanto District) in Japan. Hayashi et al. (1996) firstly reported four species of the donaciine beetles from the Upper member of the Uonuma formation in Nagaoka City, Niigata Prefecture, central Japan. Subsequently, Hayashi (1998) reexamined a species from the member and described an ex-

Contributions from the Osaka Museum of Natural History, No.351 (Accepted Jan. 10, 1999)

*Graduate School of Science and Technology, Niigata University. Ikarashi 8050, Niigata. 950-2181 Japan.

tinct species *Donaciella nagaokana*. The fossil occurrence indicates that the donaciine fauna of the Uonuma Formation also includes the extinct species.

In 1995 to 1998, I surveyed the fossil beetle assemblage from the Plio-Pleistocene Uonuma Formation at Higashikubiki hills in Niigata Prefecture, and obtained abundant donaciine fossils from lignite beds in this formation. Condition of these fossil specimens are well-preserved regarding their metallic coloration and structure of exoskeleton. It is interesting that well-preserved fossil condition is able to compare fossils with living specimens in detail. In this paper, I describe fossils of nine species including a new species, and discuss the species composition of donaciine fauna and the evolutionary significance of fossil *Plateumaris constricticollis* from the Uonuma Formation.

Methods and materials

Lignites of the Uonuma Formation including beetle fossils are compressed and cemented peaty deposits. Most fossil specimens were found by splitting them along bedding planes and examining the resulting surfaces, and preserved in shut case for wet condition with ethyl alcohol and glycerin. Most fossils and living specimens were examined under a stereoscopic microscope (SM). Most drawings and photographs were also made by using a stereoscopic microscope. Photographs of male genitalia, pygidium, and ovipositor were taken by using a light microscope (LM).

All fossil specimens described in this paper and most living specimens examined in this study, are deposited in the Osaka Museum of Natural History (OMNH). Other living specimens are in the collection of the National Science Museum in Tokyo and in the author's collection.

Geological setting

The Plio-Pleistocene Uonuma Formation is widely distributed in the Higashikubiki and Uonuma hills, southern part of the Niigata sedimentary basin, and attains more than 2,000m in the total thickness. The formation contains many characteristic volcanic ash layers which are useful for correlation (Kazaoka, 1988; Kobayashi et al., 1989). The formation is composed of fluvial and marine deposits and is divided into four members of Lowest to Upper member, on the basis of its facies and volcanic ash layers (Uonuma Hills Collaborative Research Group, 1983; Kobayashi et al., 1989; Fig. 1). The formation overlies conformably the Higashikawa and Hachioji Formations (Kobayashi et al., 1989). The formation is correlated with the Osaka Group in Kinki region and the Kazusa Group in Boso region, based on correlation of several volcanic ash layers and magnetostratigraphy (Yoshikawa et al., 1994, 1996; Tomita and Kurokawa, 1994). Especially, correlation of the Tsujimatagawa volcanic ash layer (TZC) in the Uonuma Formation with the Fukuda volcanic ash layer in the Osaka Group indicates that the Pliocene- Pleistocene boundary is situated in the Lower member of the Uonuma Formation (Yoshikawa et al., 1994). The geologic age of the formation is assigned to the Late Pliocene to earliest Middle Pleistocene

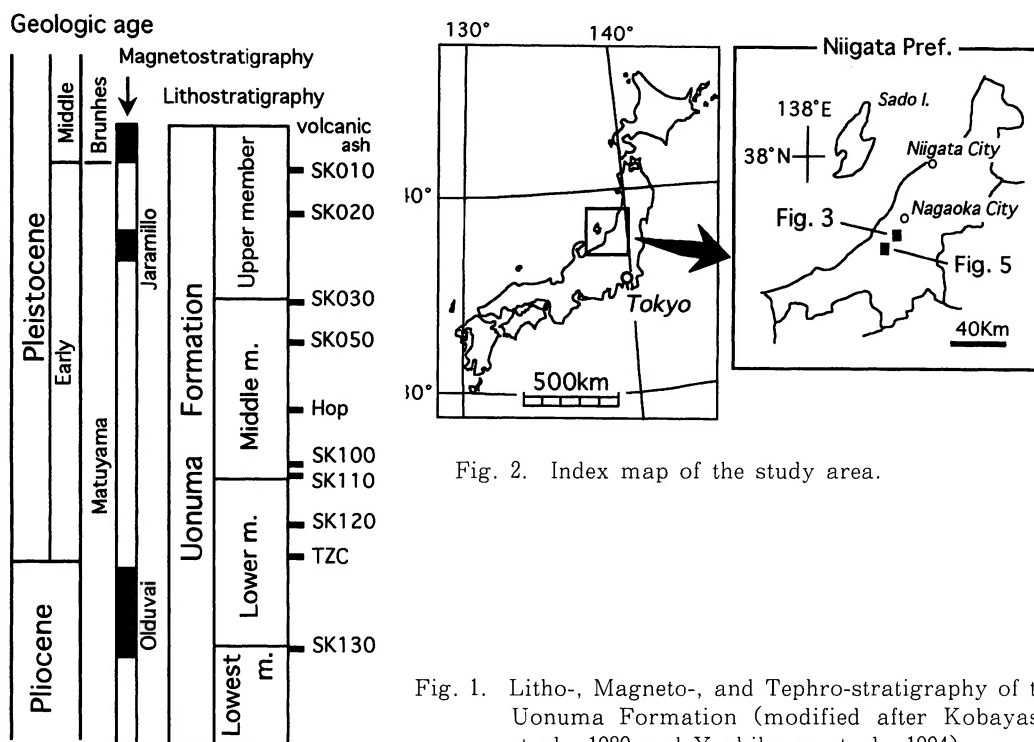


Fig. 2. Index map of the study area.

Fig. 1. Litho-, Magneto-, and Tephro-stratigraphy of the Uonuma Formation (modified after Kobayashi et al., 1989 and Yoshikawa et al., 1994).

(Yoshikoshi, 1983; Muramatsu, 1983; Yoshikawa et al., 1994).

The donaciine fossils described in this paper were collected from the Oguni and Takayanagi areas in central region of Niigata Prefecture (Fig. 2). In these areas, the formation is distributed along the Shibumigawa and Sabaishigawa Synclines. I surveyed nine routes in the areas and collected donaciine fossils from 26 localities.

Fossil localities and stratigraphic horizons

Oguni area

The investigated area of Oguni in the west flank of the Shibumigawa Syncline is shown in Fig. 3. I surveyed five routes of Shibanomata River (Route 1), Tributary of Shibanomata River (Route 2), Enmagasawa River (Route 3), Tazawa River (Route 4), and Masuzawa River (Route 5), including the type route of the Uonuma Formation. The geologic columns of these routes and their correlation are shown in Fig. 4. The Shibanomata Route is assigned to the type route of the formation, and contains thirteen characteristic volcanic ash layers of SK130, SK120, SK110, SK100, Hop, SK090, SK080, SK070, SK050, SK040, SK030, SK020, and SK010 in ascending order (Uonuma Hills Collaborative Research Group, 1983; Kazaoka, 1988). Other routes are correlated with the type route based on several ash layers such as SK120, SK110, SK100, Hop, SK050, SK030 and SK020.

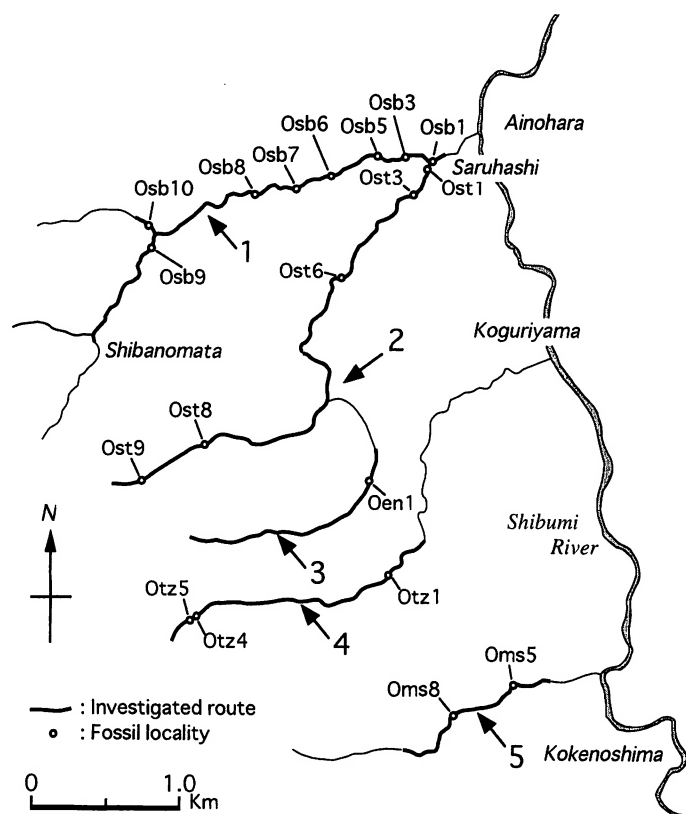


Fig. 3. Locality map of the Oguni area. Route 1, Shibanomata River (Type route of the Uonuma Formation). Route 2, tributary of Shibanomata River. Route 3, Enmagasawa River. Route 4, Tazawa River. Route 5, Masuzawa River.

The Lowest member of the formation is mainly composed of sand, but lignite bed is absent. Kobayashi et al. (1989) assigned the upper limit of the member to the upper limit of the SK130 ash layer. In the area, this member overlies conformably the Hachioji Formation of which composed of sandy silt (Kobayashi et al., 1989). The member is about 100 meters thick.

The Lower member of the formation is mainly composed of sand, but also intercalated with lignite, silt, poorly sorted sand, and gravel. Kobayashi et al. (1989) assigned the upper limit of the member to the basal limit of the SK110 ash layer. The member is about 400 meters thick. Characteristic volcanic ash layers of SK120 and TZC are contained in the member. The TZC ash layer is present in Route 3 and 4. The donaciine fossils were obtained from the member at the following localities: Osb9, Osb10, Ost8, Ost9, Ots4 and Ots5.

The Middle member of the formation is mainly composed of alternation silt and poorly sorted sand, but contains some lignite, sand, and gravel. Kobayashi et al. (1989) assigned the basal limit of the member to the basal limit of the SK110 ash layer and its upper limit to the upper limit of the SK030 ash layer. The member is about 400 meters thick. Characteristic volcanic ash layers are contained in the member such as SK110,

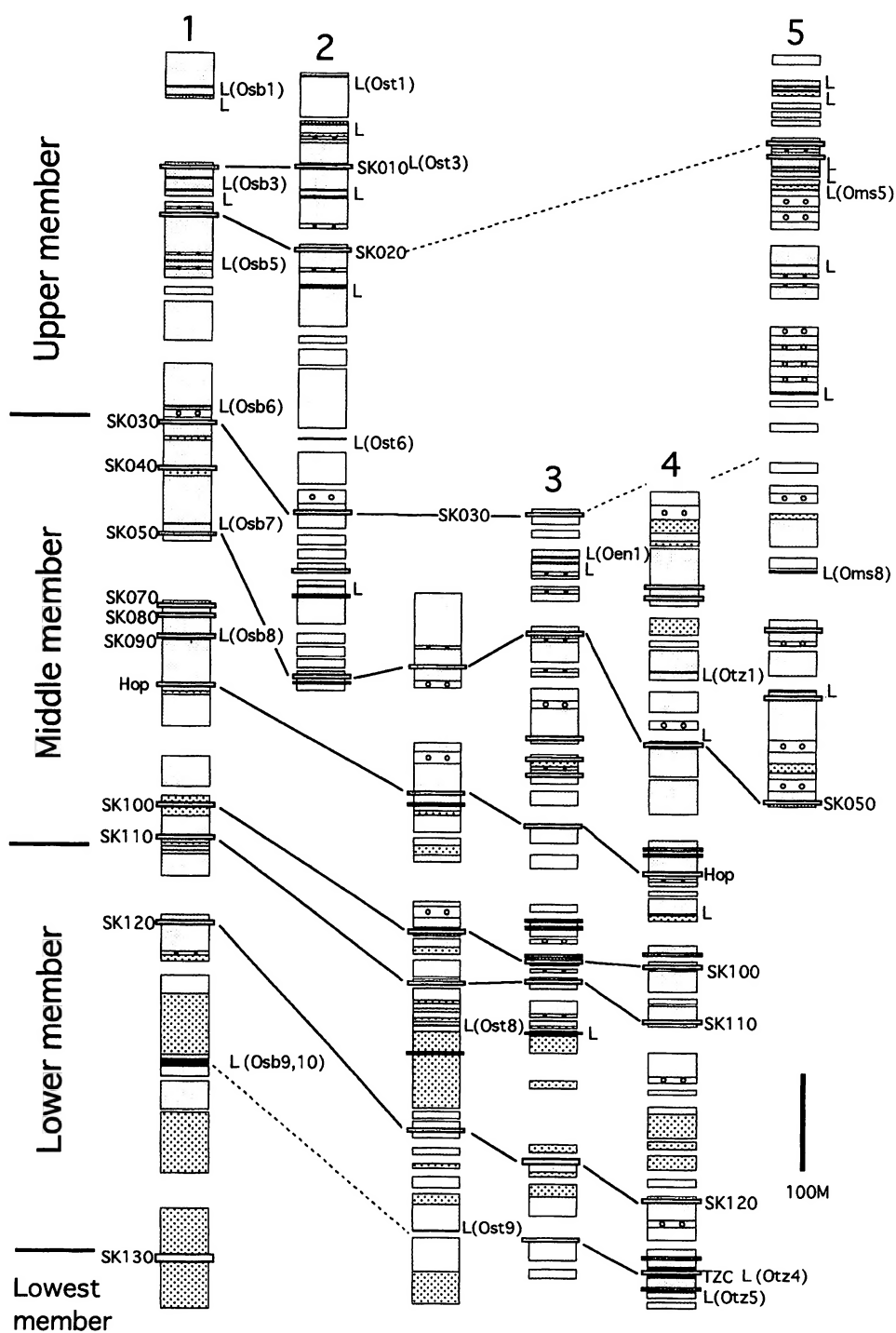


Fig. 4. The geologic columns and fossil horizons at five routes in Oguni area. Localities of each section are shown in Fig. 3 and legend of facies is shown in Fig. 6.

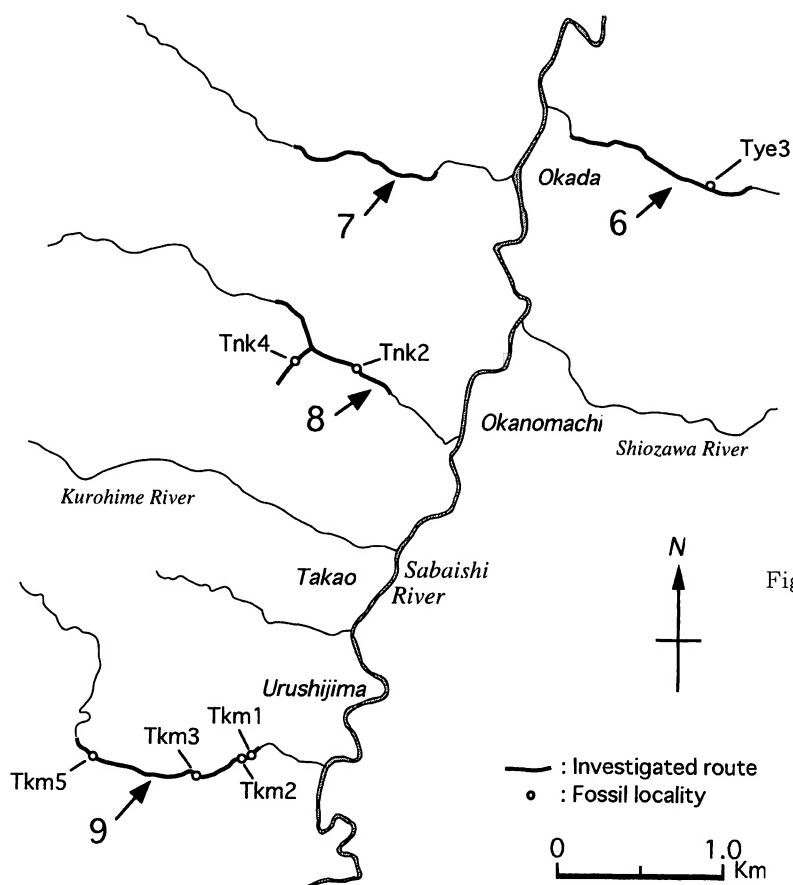


Fig. 5. Locality map of the Takayanagi area. Route 6, Yaezawa River. Route 7, Onizawa River. Route 8, Nakakura River. Route 9, Kamijima River.

SK100, Hop, SK050 and SK030. Lignite beds are scarce, especially between the SK050 ash layer above and the Hop ash layer below, within this member. The donacine fossils were obtained from the member at the following localities: Osb7, Osb8, Oen1, Otl1 and Oms8.

The Upper member of the formation is mainly composed of alternation of silt and poorly sorted sand, but contains some sand and gravel. Abundant lignite beds are present in this member. Kobayashi et al. (1989) assigned the basal limit of the member to the upper limit of the SK030 ash layer. Its thickness exceeds 450 meters. Characteristic volcanic ash layers of SK020 and SK010 are contained in the member. The donacine fossils were obtained from the member at the following localities: Osb1, Osb3, Osb5, Osb6, Ost1, Ost3, Ost6 and Oms5.

Takayanagi area

The investigated area of Takayanagi situated along the Sabaishigawa Syncline is shown in Fig. 5. I surveyed four routes: Yaezawa River (Route 6), Onizawa River (Route 7), Nakakura River (Route 8), and Kamijima River (Route 9). The geologic columns of

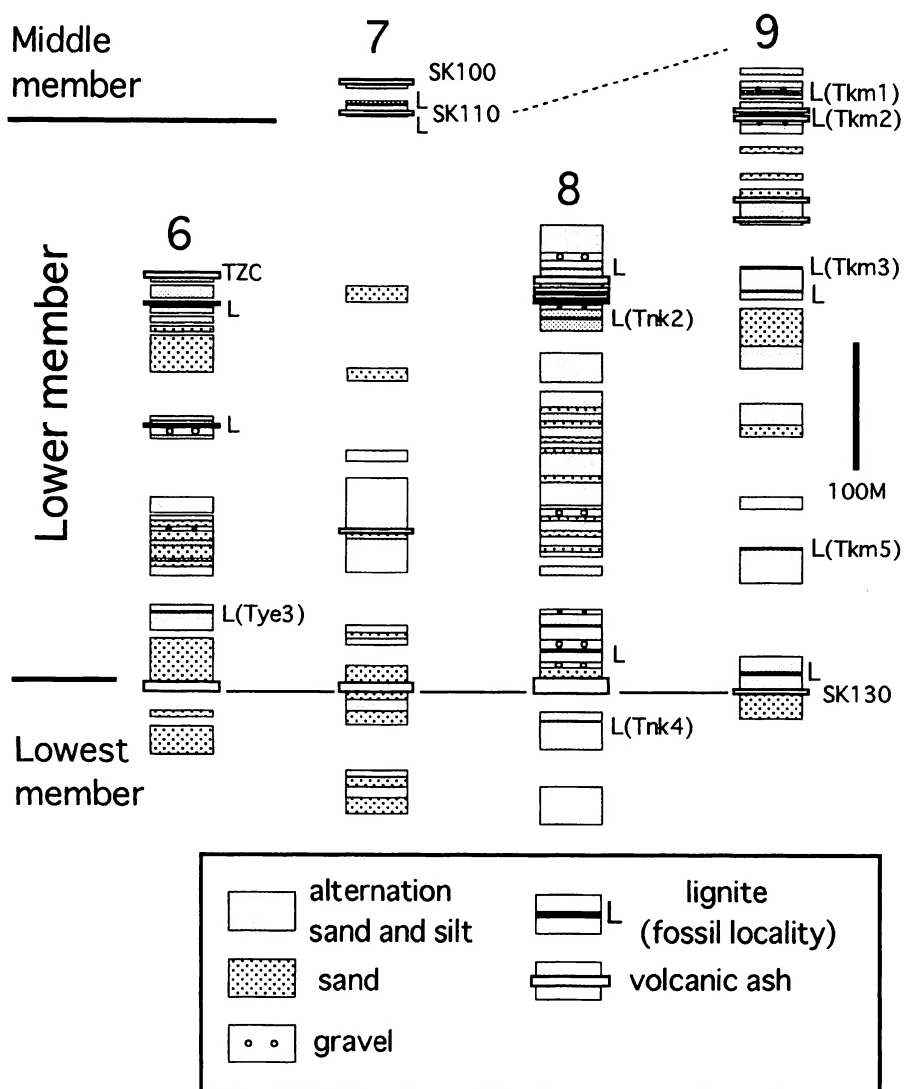


Fig. 6. The geologic columns and fossil horizons at five routes in Takayanagi area. Localities of each section are shown in Fig. 5.

these routes and their correlation are shown in Fig. 6. These routes contain several characteristic volcanic ash layers of SK130, SK110, and SK100 in ascending order.

The Lowest member of the formation is mainly composed of coarse sand and alternation of silt and poorly sorted sand, but lignite beds are scarce. This member is distributed in the area overlying conformably the Higashikawa Formation which is composed of sandy silt (Kobayashi et al., 1989). The thickness of the member exceeds 100 meters. Volcanic ash layers are scarce in the member, but only SK130 is present. The donaciine fossils were obtained from the member at locality of Tnk4.

The Lower member of the formation is mainly composed of alternation of silt and

poorly sorted sand, but contains some lignite, sand, and gravel. Lignite beds are scattered in this member. The member is about 400 meters thick. The donaciine fossils were obtained from the member at the following localities: Tye3, Tnk2, Tkm1, Tkm2, Tkm3 and Tkm5.

The outcrops of the Middle member in the area are scarce, except for riverbed of the Sabaishi River. The distributional area of this member is confined to along the axis of Sabaishigawa Syncline (Kobayashi et al., 1989).

Description of fossils

Subfamily Donaciinae Kirby

Genus *Plateumaris* Thomson

Plateumaris constricticollis (Jacoby)

(Figs. 7, 8)

Description. Pronotum and elytra entirely metallic green; metafemur metallic green in apical half and rufous in basal half, tibia rufous; pygidium metallic green but apical

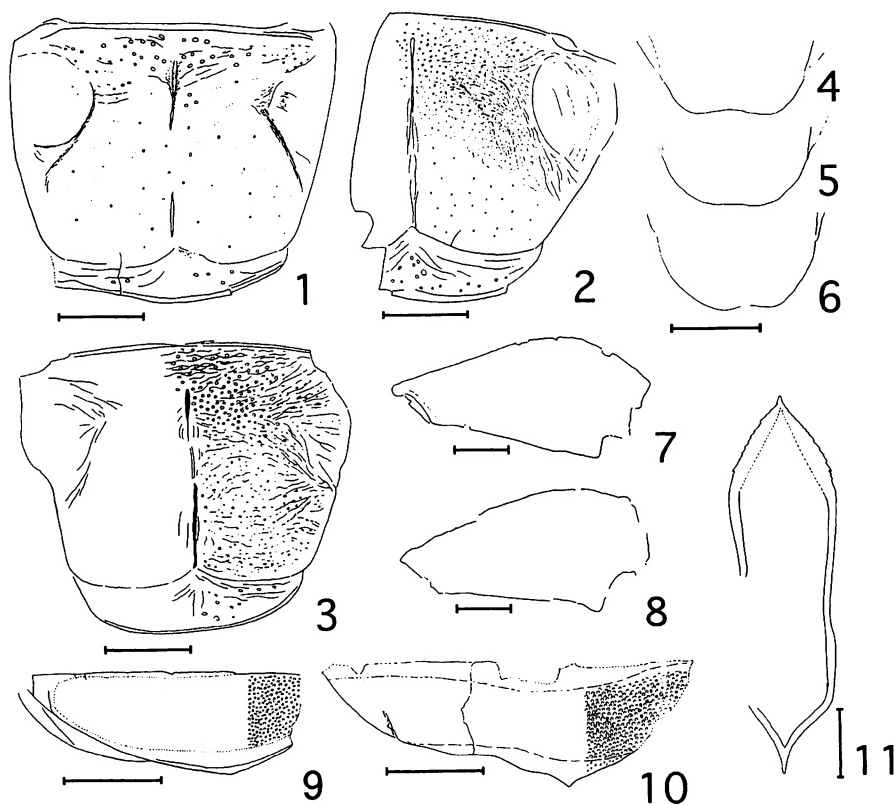


Fig. 7. 1-11, *Plateumaris constricticollis*: 1-3, pronotum; 4-6, pygidium, 4, male and 5, 6, female; 7, 8, metafemur; 9, 10, sternum of 7th abdominal segment, 9, male and 10, female; 11, ovipositor. (Scale bars = 0.5mm)

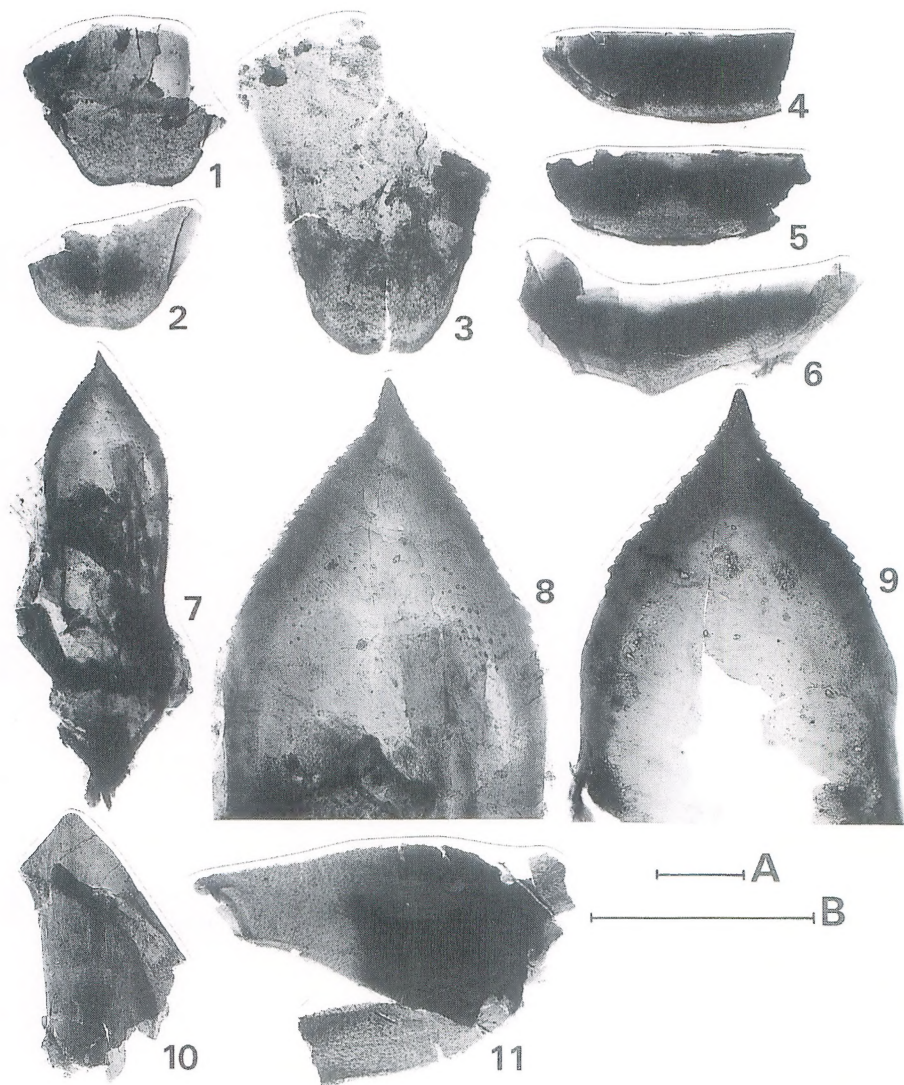


Fig. 8. 1-11, *Plateumaris constricticollis*: 1-3, pygidium, 1, male and 2, 3, female; 4-6, sternum of 7th abdominal segment, 4, 5, male and 6, female; 7-9, ovipositor, 7, general view and 8, 9, detail of apical part; 10, apical part of median lobe in male genitalia; 11, hind leg. Photograph by LM. (Scale bars = 0.5mm: A in 1-7, 11, and B in 8-10)

margin and basal part rufous; sternum of 7th abdominal segment entirely metallic green but basal and apical margins rufous. Pronotal outline more or less cordate; anterolateral calli prominent, callosal sulci present; disc entirely shiny, punctulated and rugose in anterior half, sometimes entirely rugose; basal sulcus prominent, with scattered rugae and punctures; median line deep and continuous, sometimes discontinuous. Elytron subparallel-sided from base to middle and gradually narrowed toward apex; with 10 complete punctate striae and a scutellar striole; sutural interval entirely smooth, narrowed subapically, inner

and outer beads convergent, and explanate sutural margin exposing; other intervals with transverse sparsely rugae between them, getting finer and denser apically; apex rounded, outer apical angle rounded, inner apical angle nearly right. Metafemur entirely robust in shape, with a prominent tooth. Ovipositor serrate subapical by and laterally, coarsely and more or less irregular, apical angle acute and prominent. Pygidium punctate; male pygidial apex emarginate; female pygidial apex entirely rounded, more or less emarginate. Sternum of 7th abdominal segment punctate; apical shape entirely rounded in male, projected in female. Male genitalia with a median lobe; apical angle of median lobe acute.

Measurements. Pronotum, length 1.4-2.0mm (n=26); elytron, length 5.1-6.2mm, width 1.6-2.1mm, L:W ratio 2.7-3.2 (n=4); metafemur, length 2.1-2.3mm, width 1.0mm, L:W ratio 2.1-2.3 (n=3); ovipositor, length 2.6mm, width 0.7mm, L:W ratio 3.7 (n=1).

Specimens examined. Forty-seven fossil specimens from the Uonuma Formation.

Stratigraphic horizon and locality. The Lowest to Upper members of the Uonuma Formation at Osb1, Osb3, Osb5, Osb6, Osb9, Osb10, Ost1, Ost3, Ost6, Ost9, Otz1, Otz4, Otz5, Oms5, Oms8, Tkm1, Tkm2, Tkm3, Tkm5, Tye3, Tnk2 and Tnk4.

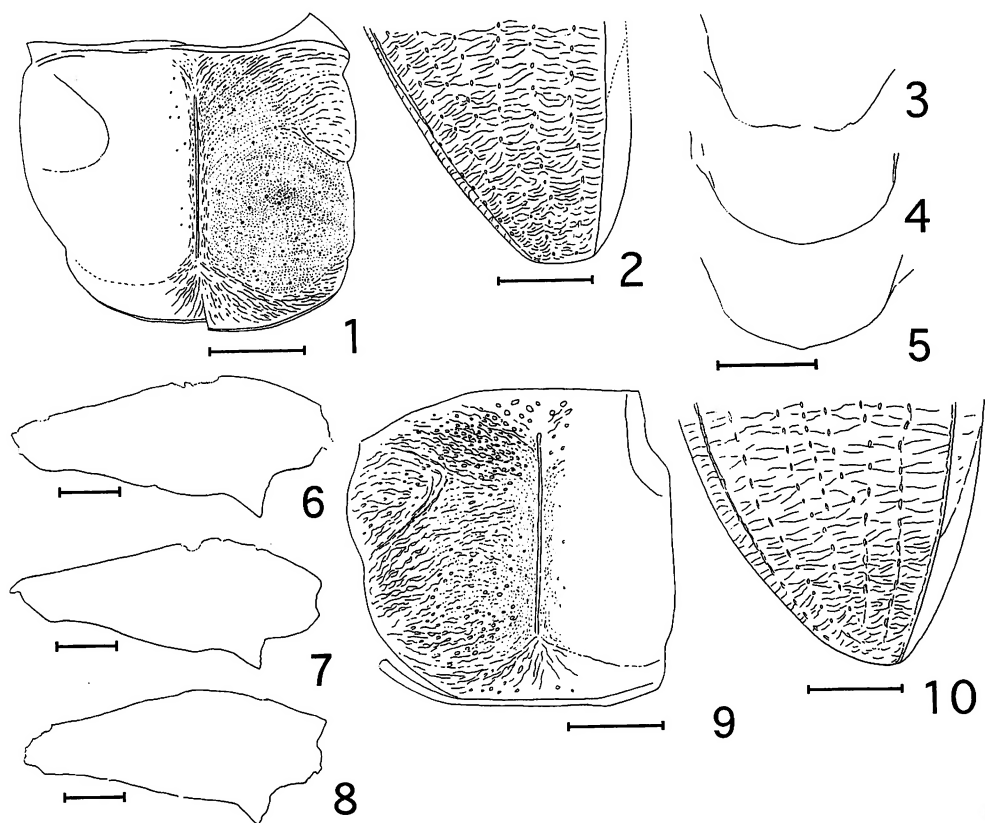


Fig. 9. 1-8, *Plateumaris virens* sp. nov. : 1, pronotum; 2, apical part of left elytron; 3-5, pygidium, 3, male and 4, 5, female; 6-8, metafemur. 9-10, *Plateumaris* sp. A : 9, pronotum; 10, apical part of left elytron.

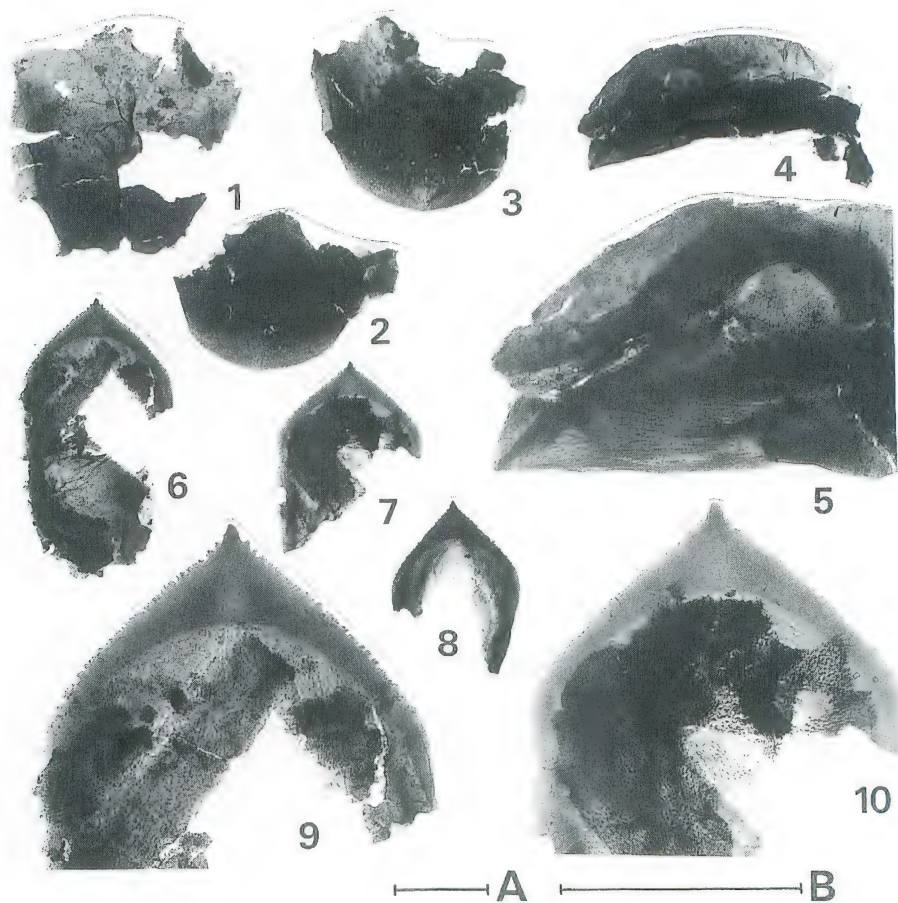


Fig. 10. 1-10, *Plateumaris virens* sp. nov. : 1-3, pygidium, 1, male and 2, 3, female; 4-5, male genitalia (lateral view), 4, general view and 5, detail of tegmen and apical part of median lobe; 6-10, ovipositor, 6-8, general view and 9, 10, detail of apical part. Photograph by LM. (Scale bars = 0.5mm: A in 1-4, 6-8, and B in 5, 9, 10)

Plateumaris virens sp. nov.

(Japanese name: Uonuma-mizukusa-hamushi)

(Figs. 9-1-8; 10; 11-1; 12-1)

Diagnosis. The new species is recognized by legs of entirely metallic green, metafemur with a blade-like tooth, truncate pygidium which is more or less emarginate in male and pointed in female, pronotum with prominent sulci and median line, pronotal disc which is sparsely punctate with microsculpture in form of transverse fine reticulation, and more or less irregular ovipositor with fine and subapical-lateral serration and pointed apex of which apical angle is nearly right.

Description. Coloration of head, pronotum, elytron, tibia, femur, sterna of thorax and abdomen entirely metallic green; pygidium metallic green but apical margin and basal part rufous. Vertex densely and coarsely punctate. Pronotal outline more or less quadrate;

anterolateral calli prominent, callosal sulci deep; disc sparsely punctate and with microsculpture in form of transverse fine reticulation nearly throughout; basal sulcus prominent, with rugae and puncture densely; median line deep and continuous. Elytron subparallel-sided from base to middle and gradually narrowed toward apex; with 10 complete punctate striae and a scutellar striole; sutural interval entirely rugose, narrowed subapically, inner and outer beads convergent, and explanate sutural margin exposing; other intervals with transverse rugae between them, getting finer and denser apically; apex more or less truncate, outer apical angle rounded, inner apical angle nearly right. Metafemur with a prominent, blade-like tooth. Ovipositor with fine and subapical-lateral serration, more or less irregular; apical angle nearly right, apex pointed. Pygidium punctate; female pygidial apex pointed or entirely rounded; male pygidial apex truncate, more or less emarginate. Sternum of 7th abdominal segment with punctation; apical shape entirely rounded. Male genitalia with a median lobe and a tegmen.

Measurements. Pronotum, length 1.5-1.7mm (n=8); elytron, length 5.8-6.1mm, width 1.5-1.6mm, L:W ratio 3.6-4.1 (n=2); metafemur, length 2.2-2.3mm, width 1.0-1.1mm, L:W ratio 2.1-2.3 (n=3).

Type series. Holotype OMNH-TI-97 (pronotum and elytra) and 28 paratypes (in coll. of the Osaka Museum of Natural History, Nagai Park 1-23, Higashi-sumiyoshi-ku, Osaka, 546-0034 Japan).

Other specimens examined. Six fossil specimens from the type locality.

Type locality and horizon. The Upper member of the Uonuma Formation at Osb6 (37° 17' 6" N; 138° 41' 13" E; alt. 90m), Shibanomata River, Saruhashi, Oguni-machi, Kariwa-gun, Niigata Prefecture, Japan.

Remarks. The genus *Plateumaris* comprises 17 Nearctic and 9 Palaearctic recent species. Askevold (1991) arranged them into five species groups by phylogenetic analysis as follows: *P. braccata*, *P. rufa*, *P. pusilla*, *P. shoemakeri*, and *P. nitida* groups.

The new species belongs to the *P. nitida*-group based on legs of entirely metallic green and metafemur with a blade-like tooth. Askevold (1991) recognized 5 Nearctic and 2 Palaearctic recent species in the group. Nearctic species, *P. balli*, *P. schaefferi*, *P. nitida*, *P. frosti*, and *P. sericea* from Japan possess emarginate pygidial apex in both sexes, but *P. sericea* from Europe, *P. shirahatai* from Japan, and Nearctic species, *P. notmani* possess rounded pygidial apex in female. However, the new species is the only species in the group that possesses pointed pygidial apex in female. The new species is most similar to the Japanese species of *P. sericea* and *P. shirahatai*, in common with most femoral and abdominal features, but is distinguishable from them in discal fine reticulation of pronotum and pointed pygidial apex in female.

Etymology. The name is derived from its body coloration.

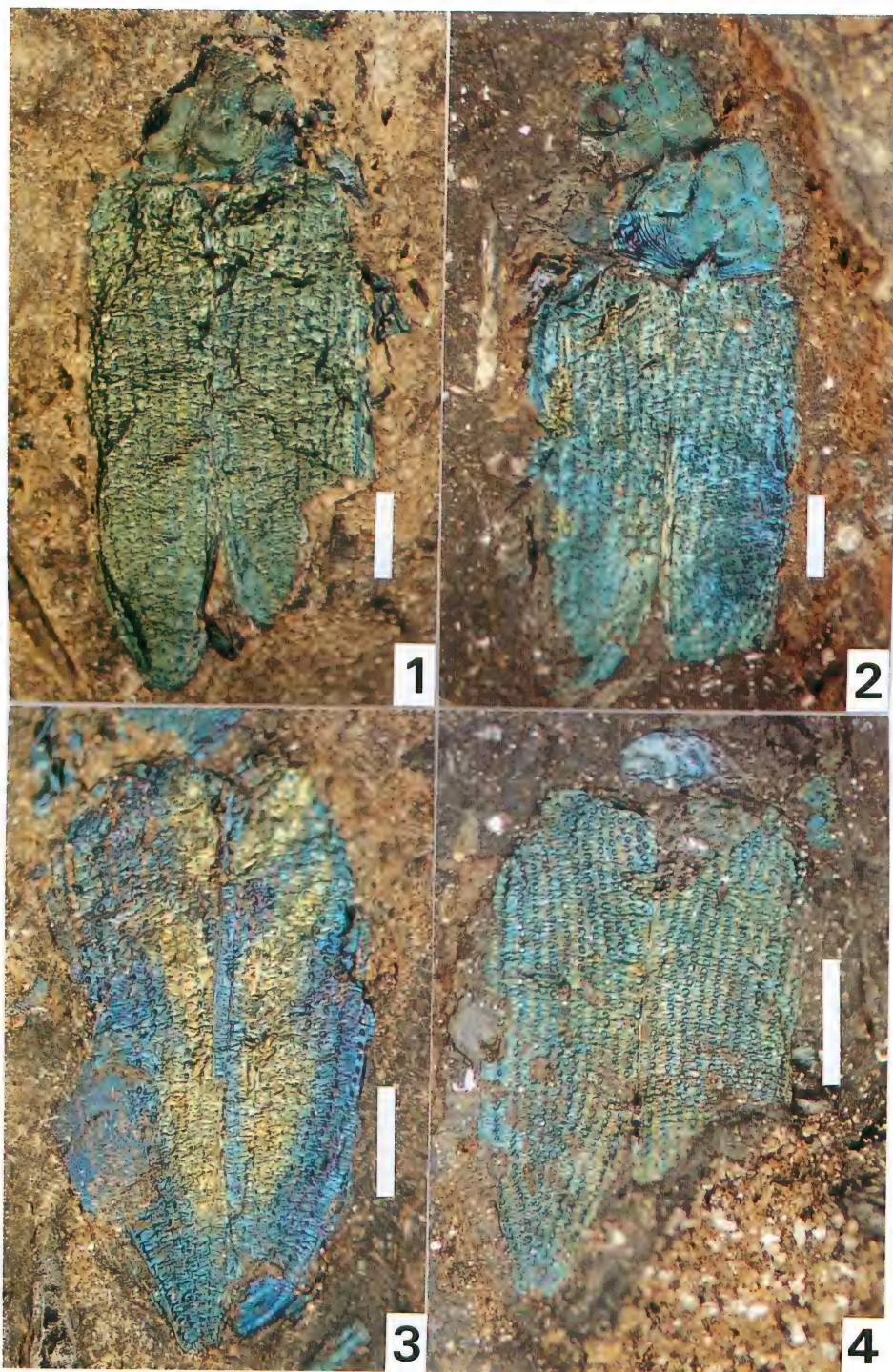


Fig. 11. 1, *Plateumaris virens* sp. nov. (holotype OMNH-TI-97), pronotum and elytra; 2, *Plateumaris* sp. A, head, pronotum and elytra; 3, *Donacia japana*, elytra; 4, *Donacia vulgaris*?, elytra. Photograph by SM. (Scale bars = 1.0mm)

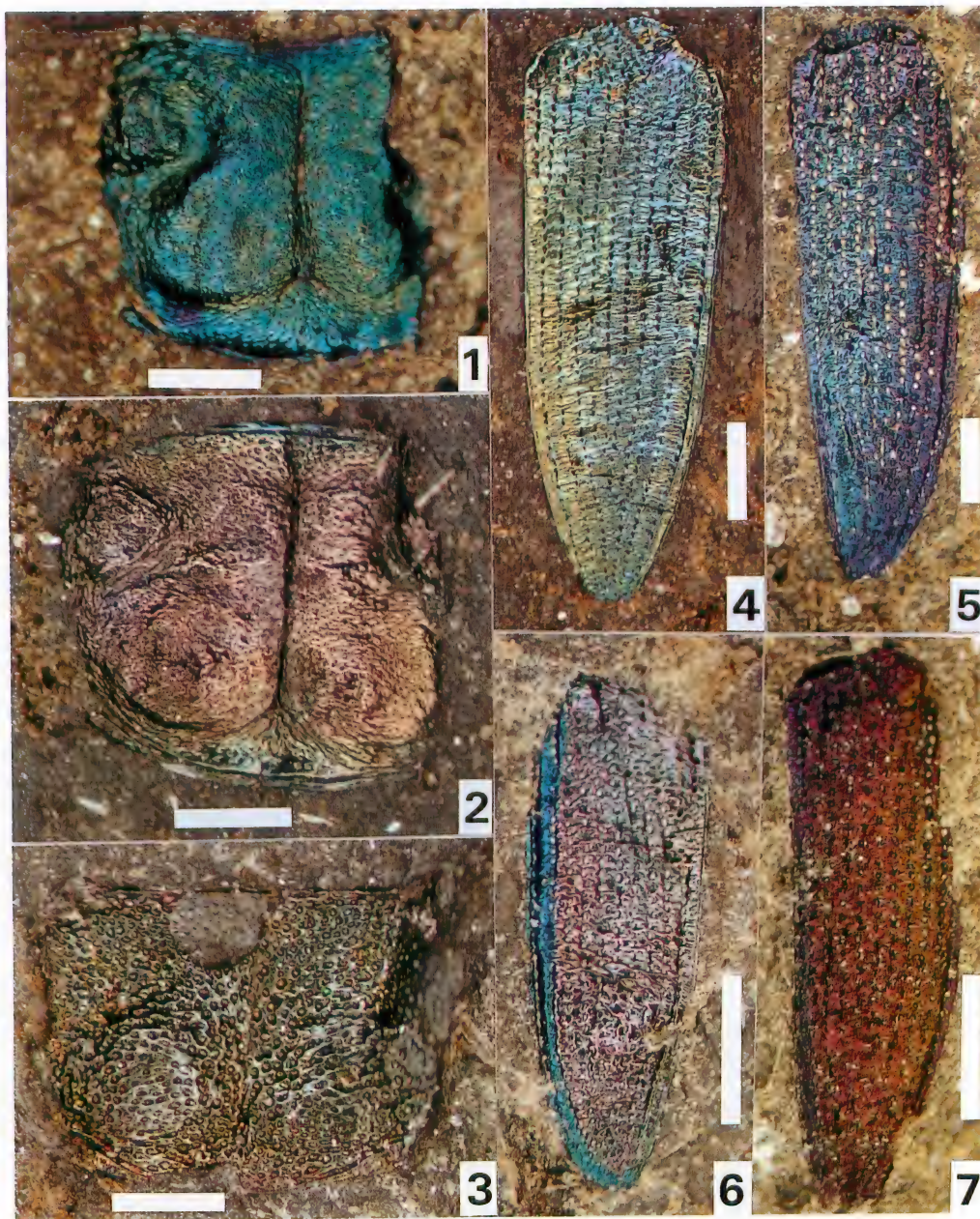


Fig. 12. 1, *Plateumaris virens* sp. nov., pronotum; 2, *Plateumaris* sp. A, pronotum; 3, 4, *Donacia clavareau*?, 3, pronotum and 4, right elytron; 5, *Donacia ozensis*, right elytron; 6, *Donacia* cf. *versicolore*a, left elytron; 7, *Donacia* cf. *provosti*, right elytron. Photograph by SM. (Scale bars = 0.5mm in 1-3 and 1.0mm in 4-7)

***Plateumaris* sp. A**

(Figs. 9-9, 10; 11-2; 12-2)

Description. Coloration of head, pronotum and elytron entirely metallic green. Pronotal outline more or less quadrate; anterolateral calli prominent, callosal sulci deep; disc punctate, in form of transverse rugae in lateral part, with microsculpture along median line; basal sulcus shallow and smooth, with rugae and puncture scattered; median line deep. Elytron subparallel-sided from base to middle and gradually narrowed toward apex; with 10 complete punctate striae and a scutellar striole; sutural interval entirely smooth, narrowed subapically, inner and outer beads convergent, and explanate sutural margin exposing; other intervals with transverse shallow rugae between them, getting finer and denser apically; apex rounded, outer apical angle rounded, inner apical angle nearly right.

Measurements. Pronotum, length 1.5-1.8mm (n=5); elytron, length 5.0-6.7mm, width 1.6-2.2mm, L:W ratio 3.1-3.2 (n=3).

Specimens examined. Six fossil specimens from the Uonuma Formation.

Stratigraphic horizon and locality. Specimens of this species were obtained from the lower member of the Uonuma Formation at Osb9 and Ost8.

Remarks. This species is distinguishable from extant Japanese members of the *Plateumaris* in pronotal characters, but I can not determine it to the specific level because most of fossil specimens are lacking useful key characters for identification.

Genus *Donacia* Fabricius**Subgenus *Donaciomima* Medvedev*****Donacia* (*Donaciomima*) *japana* Chûjô and Goecke**

(Figs. 11-3; 13-1, 2)

Description. Elytra entirely metallic green, with separated longitudinal cupreous yellow stripes in middle-apical and basal parts. Elytron subparallel-sided from base to middle and gradually narrowed toward apex; with ten complete punctate striae and a scutellar striole; stria punctures shape vertical oval; all intervals shiny; sutural interval gradually narrowing to apex, and rugose; other intervals with transverse deep rugae between them; apex truncate, outer and inner apical angle nearly right.

Measurements. Elytron, length 5.4-5.5mm, width 1.5-1.7mm, L:W ratio 3.1-3.2 (n=2).

Specimens examined. Two fossil specimens from the Uonuma Formation.

Stratigraphic horizon and locality. The Lower and Upper members of the Uonuma Formation at Osb6 and Osb10.

Remarks. This species is distinguishable from Palaearctic species, *D. aquatica*, by separated longitudinal cupreous yellow stripes in elytra. This fossil record of the species seems to be oldest in Japan.

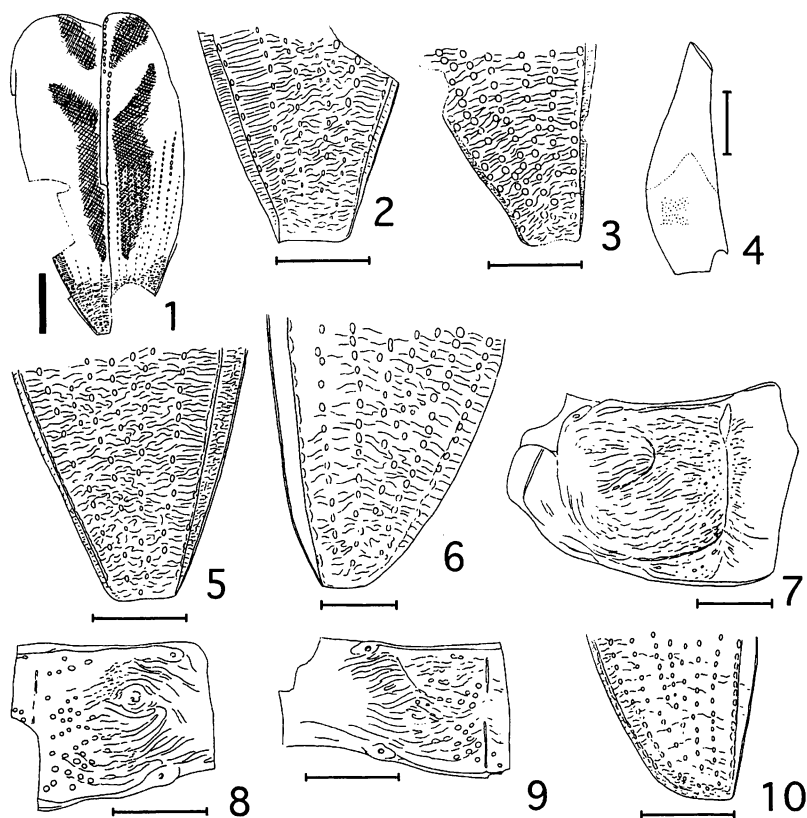


Fig. 13. 1, 2, *Donacia japana*, 1, elytra and 2, apical part of right elytron; 3, *Donacia vulgaris*?, apical part of left elytron; 4, 5, *Donacia clavareau*?, 4, metafemur and 5, apical part of left elytron; 6-7, *Donacia ozensis*, 6, apical part of right elytron and 7, pronotum; 8-10, *Donacia cf. versicolore*, 8, 9, pronotum and 10, apical part of left elytron. (Scale bars = 0.5mm in 2-10 and 1.0mm in 1)

***Donacia (Donaciomima) vulgaris* Zschach ?**

(Figs. 11-4; 13-3)

Description. Elytra entirely metallic green. Elytron subparallel-sided from base to middle and gradually narrowed toward apex; with ten complete punctate striae and a scutellar striole; strial punctures nearly circle; all intervals shiny; sutural interval gradually narrowing to apex, and rugose; other intervals with transverse deep rugae between them; apex entirely truncate, outer apical angle more or less prominent, inner apical angle right.

Measurements. Elytra, length 4.0-4.5mm, width 1.2mm, L:W ratio 3.3-3.8 (n=2).

Specimens examined. Two fossil specimens from the Uonuma Formation.

Stratigraphic horizon and locality. The Lower and Upper members of the Uonuma Formation at Locs. Ost9 and Tnk2.

Remarks. This species is most similar to the Japanese species, *D. vulgaris*, in common with rugose intervals and circle-shaped strial punctures of elytra, but living specimens

of *D. vulgaris* possess more prominent outer apical angle. If this species is identified with *D. vulgaris*, outer apical angle of the fossil elytron suggests ancestral character states of the species.

***Donacia (Donaciomima) clavareau* Jacobson ?**

(Figs. 12-3, 4; 13-4, 5)

Description. Coloration of pronotum and elytron entirely metallic green, sometimes dark blue; metafemur metallic green in apical half and in rufous basal half. Pronotal outline more or less quadrate; median line fine; callosal sulcus present, but shallow; disc coarsely punctured, in form of transverse shallow rugae; basal sulcus shallow. Elytron subparallel-sided from base to middle and gradually narrowed toward apex; with ten complete punctate striae and a scutellar striole; stria punctures nearly vertical oval; all intervals shiny; sutural interval gradually narrowing to apex, and rugose; other intervals with transverse rugae between them; apex truncate, outer and inner apical angle nearly right. Metafemur with a small tooth.

Measurements. Pronotum, length 1.3-1.5mm (n=3); elytra, length 5.3-6.2mm, width 1.6-2.1mm, L:W ratio 2.9-3.5 (n=8).

Specimens examined. Fifteen fossil specimens from the Uonuma Formation.

Stratigraphic horizon and locality. The Lower and Upper members of the Uonuma Formation at Osb1, Osb6, Osb7, Osb9, Ost1, Oen1, Tkm2 and Tye3.

Remarks. This species is most similar to the Japanese species, *D. clavareau*, in common with most pronotal, elytral and femoral characters, but living specimens of *D. clavareau* possess setaceous pronotum. In the case of fossil beetles, setae might have been disappeared from exoskeleton by fossilization. It is uncertain that fossil species possessed setaceous pronotum. Thus, I can not determine it to the specific level, although this species yielded commonly from the formation accompanied with fossils of *P. constricticollis*.

Subgenus *Donacia* Fabricius

***Donacia (Donacia) ozensis* Nakane**

(Figs. 12-5; 13-6, 7)

Description. Pronotum metallic green; elytron entirely metallic blue or green, but outer intervals (10th and 11th) and apical area metallic purple. Pronotal outline more or less quadrate; median line deep; anterolateral calli present; disc with densely transverse fine rugae; basal sulcus wide and shiny. Elytron subparallel-sided from base to middle and gradually narrowed toward apex; with ten complete punctate striae and a scutellar striole; stria punctures nearly circle basally, others vertical oval; sutural interval punctulate and smooth, 2nd to 9th intervals smooth and more or less rugose, 10th and 11th intervals rugose; apex truncate, outer apical angle obtuse, more or less rounded, inner apical angle nearly right.

Measurements. Pronotum, length 1.3mm (n=1); elytron, length 5.8-6.9mm, width 1.6-2.1mm, L:W ratio 3.0-3.6 (n=8).

Specimens examined. Nine fossil specimens from the Uonuma Formation.

Stratigraphic horizon and locality. The Lower member of the Uonuma Formation at Otz5 and Ost8.

Remarks. This fossil record of the species seems to be oldest in Japan. This species is an endemic species of Japan which only distributed in Honshu at the present time.

***Donacia (Donacia) cf. versicolore* Brahm**

(Figs. 12-6; 13-8, 9, 10)

Description. Pronotum metallic green, partly coppery; elytron entirely coppery but outer intervals (10th and 11th) and apical area metallic blue or purple. Pronotal outline more or less quadrate; median line fine; anterolateral calli indistinct; disc entirely shiny, punctate scattered by, but lateral part rugose; basal sulcus shallow. Elytron subparallel-sided from base to middle and gradually narrowed toward apex; with ten complete punctate striae and a scutellar striole; stria punctures nearly vertical oval; all intervals shiny; sutural interval gradually narrowing to apex, and smooth without rugosity; 2nd to 9th intervals smooth, more or less rugose; 10th and 11th intervals rugose; apex truncate, outer apical angle obtuse, inner apical angle right.

Measurements. Pronotum, length 0.7-0.9mm (n=2); elytron, length 3.4-4.2mm, width 1.1-1.3mm, L:W ratio 3.1-3.2 (n=3).

Specimens examined. Ten fossil specimens from the Uonuma Formation.

Stratigraphic horizon and locality. The Lower to Middle member of the Uonuma Formation at Osb7, Osb8 and Ost8.

Remarks. This species is most similar to the Palaearctic species, *Donacia versicolore* in external morphology of pronotum and elytra, but it differs from *D. versicolore* in its indistinct pronotal median line and being smaller in general size. Modern distribution of *D. versicolore* is known from Europe and Primorskij of Russia (Borowiec, 1984; Medvedev, 1992). Therefore, this species is probably same or sister species of *D. versicolore*, and it is considered that it might have become extinct in Japan after the Early Pleistocene.

Subgenus *Cyphogaster* Goecke

***Donacia (Cyphogaster) cf. provosti* Fairmaire**

(Figs. 12-7)

Description. Elytra entirely brown, partly metallic blue. Elytron subparallel-sided from base to middle and gradually narrowed toward apex; with ten complete punctate striae and a scutellar striole; stria punctures of base nearly circle; sutural interval rugose toward apex; other intervals entirely rugose; apex truncate, more or less wide, outer and inner apical angles nearly right.

Measurements. Elytron, length 3.8mm, width 1.1mm, L:W ratio 3.5 (n=1).

Specimens examined. One fossil specimen from the Uonuma Formation.

Stratigraphic horizon and locality. The Lower member of Uonuma Formation at

Ost8.

Remarks. This species is most similar to the Japanese species, *D. provosti*, in common with general and apical shape, and coloration of elytron, but I can not determine it to the specific level because a fossil specimen is lacking useful characters for identification.

Discussion

The donaciine fauna of the Uonuma Formation

The fossil assemblage of the Uonuma Formation in the Higashikubiki hills includes nine donaciine species. Three species, *Plateumaris constricticollis*, *Donacia japana*, and *D. ozensis* are extant in Japan and two species, *D. vulgaris*? and *D. clavareai*? are probably the extant species. Three species, *D. japana*, *D. vulgaris*? and *D. clavareai*? were also reported from the Upper member of the Uonuma Formation in Nagaoka City, Niigata Prefecture (Hayashi et al., 1996; Hayashi, 1998). On the other hand, *P. virens*, *P. sp. A*, and *D. cf. versicolorea* could not be identified with the Japanese extant species. It is considered that these species had been existed in Japan in the geological age and became extinct after the Early Pleistocene. However, it is possible that these species will be found living from rather insufficiently studied regions, because almost all Pleistocene beetles are extant (Coope, 1970, 1979; Elias, 1994). *Donaciella nagaokana* is also the extinct species in Japan, which was described from the Upper member of the Uonuma Formation in Nagaoka City (Hayashi, 1998), but this species could not been obtained from the formation in the area. The donaciine fauna of the Uonuma Formation indicates that the recent Japanese species

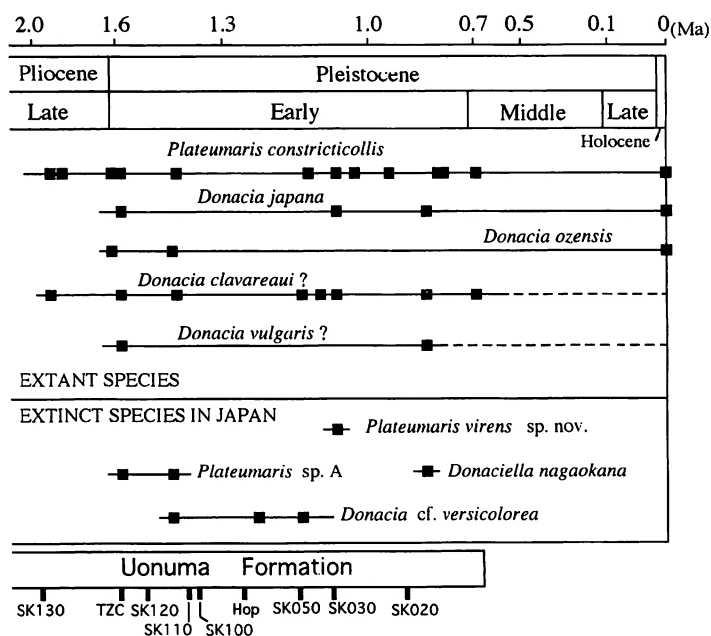


Fig. 14. Fossil records of the donaciine beetles from the Uonuma Formation. Data from Hayashi et al., (1996), Hayashi (1998), and present study.

can be traced back to before the Pleistocene and the Early Pleistocene donaciine fauna of the Niigata region includes four extinct species in Japan (Fig. 14).

Evolutionary significance in the fossils of *Plateumaris constricticollis* from the Uonuma Formation

Plateumaris constricticollis is an endemic species of Japan and divided into five subspecies, *P. constricticollis constricticollis* (Jacoby), *P. c. kurilensis* Medvedev, *P. c. babai* Chûjô, *P. c. toyamensis* Tominaga and Katsura, and *P. c. chugokuensis* Tominaga and Katsura, at the present time (Chûjô, 1959; Medvedev, 1978; Tominaga and Katsura, 1984). Their modern distributional pattern is allopatric (Fig. 15). North-eastern subspecies group (subsp. *constricticollis* s. str. and *babai*) possess wide and continuous distributional range, and western subspecies group (subsp. *toyamensis* and *chugokuensis*) possess narrow distributional range. Both subspecies groups are also different in the external morphology. North-eastern subspecies group is characterized by shiny pronotum, ovipositor with coarse subapical-lateral serration and very acute apex, and western subspecies group is characterized by the rugose pronotum, ovipositor with fine subapical-lateral serration and obtuse apex which is shorter than in the former. The investigated area is situated in the modern distributional range of subsp. *babai* of which is living in small marsh of reeds and sedges around the fossil localities. It is interesting that general size of subsp. *babai* (especially, population of the central region of Niigata Prefecture) is largest of all subspecies. However, fossil specimens of this species are most similar to the modern subspecies of *chugokuensis* in general size, in common with several characters as follows: pronotal disc punctulated and rugose in anterior half, sternum of 7th abdominal segment entirely and darkly rufous, male pygidial apex emarginate, small-sized pronotum and elytra (Fig. 8-1; 8-4,5,6). On the other hand, ovipositor of fossil specimens with subapical-lateral tooth and apical angle prominent that character state is most similar to the subsp. *babai* (Fig. 8-7,8,9).

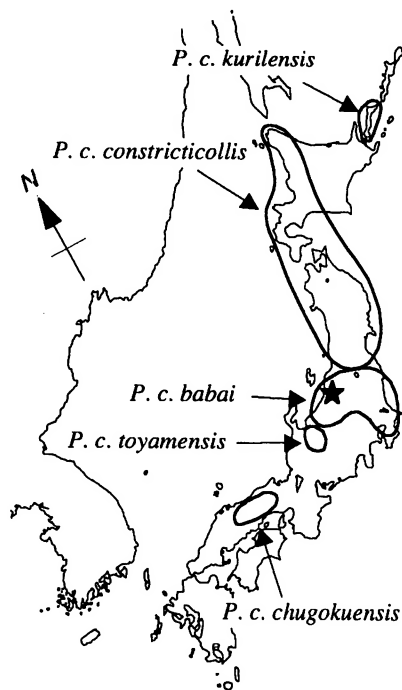


Fig. 15. Known distribution of subspecies of *P. constricticollis*, based on data from Tominaga and Katsura (1984), Satoh (1989a, b), Medvedev (1978), and my specimens examined. A star indicates the fossil localities of the Higashikubiki hills.

Tominaga and Katsura (1984) considered that the ovipositor is most important character for distinguishing north-eastern and western subspecies groups. The fossil specimens from the formation indicate that the ancestral character state of subsp. *babai* was similar to the western subspecies group (especially, *chugokuensis*) in most external characters, but whose ovipositor was similar to that of subsp. *babai*.

Acknowledgements

I am deeply indebted to Prof. Iwao Kobayashi, Niigata University, for valuable discussions and supporting this study. I gratefully acknowledge Mr. Shigehiko Shiyake, Osaka Museum of Natural History, and Dr. Syuhei Nomura, National Science Museum, for allowing accesses to the referred materials.

Literature Cited

- Askeveld, I. S. 1991. Classification, reconstructed phylogeny, and geographic history of the New World members of *Plateumaris* Thomson, 1859 (Coleoptera: Chrysomelidae: Donaciinae). Mem. Ent. Soc. Can. (157): 5-175.
- Chûjô, M. 1959. Contribution to the fauna of Chrysomelidae (Coleoptera) in Japan (III). Memoirs of the Faculty of Liberal Arts & Education, Kagawa University (Part II) (81): 1-16.
- Coope, G. R. 1970. Interpretations of Quaternary insect fossils. Ann. Rev. Entomol. 15: 97-120.
- Coope, G. R. 1979. Late Cenozoic fossil Coleoptera: evolution, biogeography and ecology. Ann. Rev. Ecol. Syst. 10: 247-267.
- Elias, S. A. 1994. Quaternary insects and their environment. Smithsonian Institution Press, Washington D. C., 284p.
- Hayashi, M. 1998. A new species of the genus *Donaciella* from the Lower Pleistocene in Nagaoka City, Niigata Prefecture, central Japan (Coleoptera: Chrysomelidae: Donaciinae). Bull. Osaka. Mus. Nat. Hist. (52): 37-47.
- Hayashi, M., Kato, M. and Kobayashi, I. 1996. Insect fossils from the upper part of the Uonuma Formation, Nagaoka City, Niigata Prefecture, Japan. Bull. Nagaoka Municipal Sci. Mus. (31): 109-116. (in Japanese, with English abstract)
- Kazaoka, O. 1988. Stratigraphy and sedimentary facies of the Uonuma Group in the Higashikubiki Hills, Niigata Prefecture, Central Japan. Earth Sci. (Chikyû Kagaku) 42(2): 61-83. (in Japanese, with English abstract)
- Kobayashi, I., Tateishi, M., Kurokawa, K., Yoshimura Y. and Kato, H. 1989. Geology of the Okanomachi district. Geol. Surv. Japan, 112p. (in Japanese, with English abstract)
- Medvedev, L. N. 1978. Taksonomicheskie zametki o geukaha-listoedak (Coleoptera, Chrysomelidae) Sakhalina i Kurilskik Ostrovov. Trudi Biologo-potiennoogo instituta, Nobaya seriya 50(153): 82-86. (in Russian)
- Muramatsu, T. 1983. Fission track ages of the Uonuma Group, Niigata Prefecture, Central Japan. Monograph, Assoc. Geol. Collab. Japan (26): 63-66. (in Japanese, with English abstract)
- Satoh, K. 1989a. Notes on Donaciinae beetles (Coleoptera, Chrysomelidae) in Tochigi

- Prefecture. Bull. Tochigi Prefec. Mus. (6): 15-42. (in Japanese)
- Satoh, K. 1989b. Notes on the Distribution of the Donaciine beetles (Coleoptera, Chrysomelidae) in Miyagi Prefecture. Bull. Tochigi Prefec. Mus. (6): 43-48. (in Japanese)
- Tominaga, O. and Katsura, K. 1984. Studies on the Japanese Donaciinae (Coleoptera: Chrysomelidae) 2. Notes on geographical diversity of *Plateumaris constricticollis*, with descriptions of an allied new species. Bull. Osaka Mus. Nat. Hist. (37): 25-40, plate 8.
- Tomita, Y. and Kurokawa, K. 1994. Correlation between the Osaka Pink ash in the Osaka Group and the Ogi ash in the Niigata region. Earth Sci. (Chikyu Kagaku) 48(5): 467-476. (in Japanese, with English abstract)
- Uonuma Hills Collaborative Research Group (ed.) 1983. The Uonuma Group. Assoc. Geol. Collab. Japan, Tokyo, 186p. (Monograph No. 26). (in Japanese, with English abstract)
- Yoshikawa, S., Tateishi, M. and Kazaoka, O. 1994. Correlation of Fukuda volcanic ash layer in the Osaka Group and Tsujimatagawa volcanic ash layer in the Uonuma Group, central Japan. Jour. Geol. Soc. Japan 100(7): 486-494. (in Japanese, with English abstract)
- Yoshikawa, S., Satoguchi, Y. and Nagahashi, Y. 1996. A widespread volcanic ash bed in the horizon close to the Pliocene-Pleistocene boundary: Fukuda-Tsujimatagawa-KD38 volcanic ash bed occurring in central Japan. Jour. Geol. Soc. Japan 102(3): 258-270. (in Japanese, with English abstract)
- Yoshikoshi, M. 1983. Magnetostratigraphy of the Uonuma Group in the Oguni district, Niigata Prefecture, Central Japan. Monograph, Assoc. Geol. Collab. Japan (26): 57-62. (in Japanese, with English abstract)

APPENDIX 地名のローマ字表記

Enmagasawa River (Enmaga-sawa : えんまが沢) , Kamijima River (Kamijima-gawa : 上島川) , Masuzawa River (Masuzawa-gawa : 増沢川) , Nakakura River (Nakakura-gawa : 中倉川) , Oguni (小国 : 刈羽郡小国町), Onizawa River (Onizawa-gawa : 鬼沢川) , Sabaishi River (Sabaishi-gawa : 鯖石川), Shibanomata River (Shibanomata-gawa : 芝ノ又川) , Shibumi River (Shibumi-gawa : 渋海川), Takayanagi (高柳 : 刈羽郡高柳町), Tazawa River (Tazawa-gawa : 田沢川) , Yaezawa River (Yaezawa-gawa : 八重沢川).